NUTRACEUTICAL POTENTIAL OF THREE WILD EDIBLE MUSHROOMS Lycoperdon pyriforme, Arimillaria tabescens and Agaricus bisporus AVAILABLE IN THE FOOTHILLS OF EASTERN GHATS NEAR PONNAI, VELLORE DISTRICT

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Abstract: The present study was carried out to evaluate the nutritional and medicinal properties of wild grown mushrooms collected from foothills of Eastern Ghats hills near Ponnai Village at Vellore District, Tamilnadu, India. A vast screening study conducted to identify the edible and non-edible mushroom in these regions showed three mushroom species such as Lycoperdon pyriforme, Arimillaria tabescens, Agaricus bisporus were prominent distributed when compared to the other mushrooms. Hence, the nutritional and nutraceuticals value of these all three wild mushroom species were analysed and reported herein. The carbohydrate contents in these mushroom ranged from 20.34±1.8 - 31.46±2.6 (g/100g). The protein content was ranged from 15.28±1.3 - 25.32±1.8 (g/100g), fat were ranged from 2.7±0.21- 3.4±0.21 (g/100g) and fibres were ranged from 14.39±1.1- 21.37±1.9 (g/100g). The moisture was ranged between 85.4±7.4% - 90.68±8.3percent and ash content was ranged from 4.8±1.4 - 6.4±0.8 (g/100g). The essential amino acids content were ranged from 05.5-50.8mg/g in Lycoperdon pyriforme, 06.7-60.4mg/g in Arimillaria tabescens and 03.6-67.1mg/g in Agaricus bisporus respectively. The vitamins B1, B2, B3, B6, B7, B9, B12, C, D2 and D4 levels analysed and their ranges were from 0.006±0.00050-5.1±0.53 mg/100g in all three mushrooms. The lowest concentrations were observed in vitamin D4 and highest levels in B9. The minerals level were ranged from 0.3-815mg/100g (Lycoperdon pyriforme), 0.7-690mg/100 (Arimillaria tabescens) and 0.6-734 (Arimillaria tabescens). In all three mushrooms the minimum levels were observed for Iron (Fe) content and maximum levels were for Phosphorous (P) content.

Key words - Nutraceuticals, Lycoperdon pyriforme, Arimillaria tabescens, Agaricus bisporus, mushroom, carbohydrate, protein, fat, ash, moisture, amino acids, minerals, vitamin.

I. Introduction

The word nutraceuticals is very popular today; this term was first coined in 1979 by Stephen Deflice, founder and chairman of the foundation for Innovation in Medicine located at Cranford, New Jersey. In term nutraceuticals, the word “nuta” refers nutrition and “ceutical” refers pharmaceutical that means the substances which may be considered a food or part of a food and may provide health benefits, including the prevention and treatment of diseases (Biesalski, 2001). At the beginning, this word is applicable for limited items such as isolated nutrients, herbal products, dietary supplements, nutraceuticals, and diets to genetically engineered designer foods and processed products such as cereals, soups, and beverages. Doubtlessly, many of these products possess pertinent physiological functions and valuable biological activities (Andlauer and Fürst, 2002), then, it extended to vitamins, minerals, herbs, botanicals, amino acids, and any dietary substances used by humans to fortify the diet by increasing total dietary intake by the Dietary Supplement Health and Education Act of 1994 (Stauffer,1999 and Whitman,2001). Recently, term “mushroom nutraceuticals” coined by Chang and Buswell is highly familiar among the scientific communities and even among common educated peoples (Chang and Buswell,1996) because of their potential dietary supplements, health enhancement and various human diseases prevention properties. From the period of time inmmemorial, the mushrooms have been taken as food for their nutritional value as well as medicine for their medicinal value. Mushrooms have become attractive as a functional food and as a source for the development of drugs and nutraceuticals (Lakhanpal and Rana, 2005). Total mushrooms on the earth are estimated to be 140,000 species, among these, 2,000 are safe for human consumption and about 650 of these possess medicinal properties (Rai et al., 2005). Hence, in the present investigation, the waste land in the foothills of Eastern Ghats near Ponnai Village, Vellore District was selected to screen for the edible and non-edible mushroom. Among these, three dibble species of wild mushroom such as Lycoperdon pyriforme, Arimillaria tabescens, Agaricus bisporus were selected to evaluate their nutraceuticals potentiality.

II. Materials and method

2.1. Collection and identification

The wild edible mushrooms for the present study were collected from waste land in the foothills of Eastern Ghats near Ponnai Village, Vellore District. Specimen collection was done regularly from the above-mentioned collection area during rainy months from August to November for consecutive two years (2016 to 2018). The information about the edibility, poisonous impact on health, ritual usage and nutraceutical potential was collected by discussion and direct interview with local people and by direct observation on the way different mushrooms were being collected and used. All the stories documented during interview of local people were further verified to know their reliability by cross questioning the elders in the village about the key
information and already documented literature. Both the poisonous and non-poisonous mushrooms were randomly collected and stored in perforated plastic bags. During collection, the damaged, infected and very young fruitbodies were avoided. Mushrooms collected from different places or different species were kept separately. The information about the substrate such as decayed wood parts and dead plants remnants or growing ground soil type, moisture level and air temperature of specimen collected areas were carefully noted. After the specimens were brought to the laboratory, the macroscopic and microscopic properties were identified by using identification key and literature according to Ramsbottom (1965), Singer (1986), Bessey (1978), Thind (1961), Purkayastha and Chandra (1985) and Roy and De (1996). Then the specimen identification further confirmed and authenticated at species level by sending it to Pro.Dr.Jeyaraman, Department of Botany

2.2. Total carbohydrate

The total carbohydrate content of the fruit body of mushroom was estimated by Molisch’s test. 2 ml of mushroom was taken in a test tube. Along with freshly prepared 1ml of 20% alcoholic solution and 1ml of concentrated sulphuric acid was added along the sides. The reddish violet and purple colour developed at junction between two liquids indicates the presence of carbohydrates.

2.3. Protein test

The protein content of the mushroom fruit body was estimated by Biuret’s test. 2 ml of mushroom extract was taken in a test tube. Along with 1 ml sodium hydroxide solutions (40%) and 2 drops of copper sulphate solution (1%) was added and mixed properly. The pinkish - violet colour formed in the test tube indicate the presence of proteins.

2.4. Fat test

The presence of fat in the mushroom fruit body was confirmed by Saponification test. 2ml of plant extracts was taken in a test tube. Along with, 2% sodium carbonate solution was added, mixed well, shaken vigorously and boiled. Then, a clean soapy solution formed was cooled and along with few drops of conc. HCl was added. The fat content was separated out and floated on the surface of the mixture solution indicate the presence of fat.

2.5. Crude fiber estimation

2 gm of dried mushroom powder was taken in beaker and underwent to the following serial repeated boiling and washing process to obtain pure crude fibre. In the first step, the mushroom powder was boiled with 200 ml of sulphuric acid (1.25 % w/v) for 30 min. This boiled solution was filtered through muslin cloth. In the second step, the filtrate obtained on the muslin cloth was washed with boiling water until the complete removal of acid. In third step, the filtrate obtained was further boiled with 200 ml of sodium hydroxide (1.25 % w/v) solution for 30 min and filtered through muslin. In the fourth step, filtrate was again washed with 25 ml of boiled 1.25 % w/v sulphuric acid and washed thrice with water and finally with 25ml absolute alcohol. After the completion of all the repeated boiling, filtration and washes, the residue obtained was then transferred into pre weighed ash dish and dried for 2 h at 130C. The dry weight was taken and the residue was ignited for 30 min at 660 ± 150C cooled in a desiccator and reweighed. The crude fibre was calculated according to the method of Maynard (1970).

2.6. Moisture content estimation

For this estimation, 10 gm of fresh mushroom was taken in a watch glass and kept in oven drier at about 600C for 72 h to allow the complete removal of moisture content. Then, these dried sample was again weighed and the moisture percentage (M%) was calculated by using the following formula.

\[
\text{Moisture }\% = \frac{\text{(Fresh Wt.)}}{\text{(Dry Wt.)}} \times 100
\]

2.7. Ash estimation

For this estimation, 2 gm of mushroom powder was taken in a lidded porcelain cup and kept in a muffle furnace at 550 C for 24 h heated. The resulting ash content of the material was weighed again and the amount of ash was determined by using the following formula.

\[
\text{Ash }\% = \frac{\text{(Dry Wt.)}}{\text{(Dry powder Wt.)}} \times 100
\]

2.8. Amino acids test

The presence of amino acids in the mushroom fruit body was confirmed by Xanthoprotein test. 2 ml of mushroom extracts was taken in test tube. Along with, 1ml of conc. nitric acid was added. A white precipitate was formed inside the test tube heated up to turns yellow colour, then, cooled the solution carefully. Thereafter, 2ml of 20% sodium hydroxide solution was added in excess, which produced orange colour that indicates the presence of amino acids.

2.9. Vitamin analysis

2.9.1. Collection and processing of samples

The present vitamin B series were conducted for the wild edible mushroom obtained from foothills of Eastern Ghat near Ponnai village, Vellore District. The moisture content of the mushroom were maintained by spray the water on it which was loosely covered by clean dark plastic poly bags to prevent water loss, denature and damage caused by sun light and heat. This packed mushroom samples were then transported to lab within shortest time span. There, these samples were washed well with water. The excess water in the mushroom was removed by blotting paper. The fruiting body of the mushroom samples were then
separated and weighed. These were chopped out into small pieces and homogenized. About 10gm sample from the chopped were taken for vitamin B series analysis.

2.10. Reagents and solvents required

The analytical grade chemical reagents such as HPLC Methanol (Merck); Acetonitrile (Merck); Glacial Acetic acid (BDH); Triethylamine (RDH); Orthophosphoric acid (BDH); Hexane Sulphonic Acid Sodium Salt (Merck); distilled water and de ionized water by using Millipore direct Q system were required for this analysis.

2.11. Apparatus used in the estimation

Major equipment used in the vitamin B series analysis were HPLC (Shimadzu Corporation, Japan); Electrical Balance, Metter, Toledo AB 104; Distillation Chamber; Digital pH meter (Made in Mauritius, HI98107); Magnetic stirrer; Vortex mixer; Refrigerator; Micropipettes; Pipette pillar; Glass wares.

2.12. Analysis of Vitamin B series by integrated HPLC system

The mushroom extract obtained from all three study mushrooms were filtered through a 0.45µm filter (Millipore) and injected to HPLC vial. Then HPLC analysis was carried out on a Shimadzu’s LC-2010 HPLC system.

Standard vitamin solution preparation

Standard vitamins (B1, B2, B3, B6, B9, B12 and C) were purchased and standard stock solutions at concentration of (2000 mg/l) were prepared by dissolving 0.2 g of each vitamin in 40 ml deionized water and then diluted solution to100ml.

2.13. Buffer preparation

In a well cleaned 1.5 litre beaker containing 940 ml HPLC water, 1.36gm of potassium dehydrogenate phosphate and 1.08gm of hexane sulphonic acid sodium salt were dissolved. In this mixture 5ml of triethylamine was added. Thereafter, pH of this solution was adjusted to 3.0 with the help of orthophosphoric acid. Finally, this buffer was mixed with menthol in the ratio of 96:4 and filtered through 0.45µm membrane filter and degassed by using helium gas. Then this buffer solution was used for mobile phase.


50ml of acetonitrile mixed with 10ml of glacial acetic acid. The final volume made up to 1000ml with double distilled water.

2.15. Preparation of samples

From each mushroom sample 10gm of fruiting body was taken and homogenized well by mortar and pestle. Then the homogenized tissues were transferred to conical flasks, along with 25ml of extraction solution was added and kept on shaking hot water bath at 70ºC for 40 min. Thereafter, the sample was cooled down and filtered. The final volume of filtrate made up to 50ml using extraction solution. Then again the sample was filtered through 0.45µm filter tips. From this filtrate 20µl of solution was injected into the HPLC by using auto- sampler.

2.16. Analytical conditions

The constant flow rate 1ml/min with 2300 pressure by using waters pump (1515 isocratic were set for mobile phase Buffer: menthol (96:4). The UV (2487) detector attached with the waters symmetry C18 column (4.6x150mm, 5µm) contained HPLC was employed for the detection of peaks, using channels at a wavelength of 210nm, a 5nm of bandwidth. Thereafter, 20µL aliquots of the standard solutions and sample solutions were injected. Prior to the injection, all analytical solutions were degassed by sonication.

2.17. Vitamins estimation

Five different concentrations of standard vitamin solution such as 5µg/mL, 10µg/mL, 15µg/ mL and 30µg/mL) were prepared for each vitamin by diluting with HPLC water. Then 20µl from each diluted solution was injected into HPLC using auto-sampler and the analyses were monitored at 210nm and repeated three times. The average peak areas were plotted against concentrations. The linearity of the proposed method was evaluated by using calibration curves to calculate coefficient of correlation, slope and intercept values. The content of B-vitamins (x) was calculated by using the plotted peak areas (y) of three samples of the each mushroom slope (m) and intercept (c) from the calibration curves of vitamins standards in this equation, y=mx+c, Then result was multiplied by dilution factor.

2.18. Mineral estimation

The mineral concentration in the mushroom was estimated by AAS (Atomic absorption spectrophotometric method) followed by Ruperez (2006). 1 g of dried powder of mushroom was taken in a test tube and digested in 5ml of nitric acid and 2.5 ml of perchloric acid (2:1 ratio) mixture by heating up to 100c for 12 hours in boiling water bath and cooled. If any remnants present in the mixture, they are further digested in 2.5 ml of nitric acid by heating in boiling water bath upto more than 4 hours until the solution become more transparent. Finally, the digested solution was cooled and filtered through Whatman no. 1 filter paper and made up the volume to 100 ml with deionized distilled water (working standard). Simultaneously, a reagent blank was prepared by taking 14 ml of de-ionized distilled water in a test tube. The absorbance was measured at 422.67nm for (Ca), 371.99nm (Fe), 403.08nm for Mn, 307.59nm Zn for nm in an atomic absorption spectrophotometer (AAS). The mineral concentrations in the mushroom were expresses in the unit ppm.

III. Results and discussion

Mushrooms are good source of quality protein, minerals and vitamins (Wahid, et al. 1988). Mushrooms are considered as source of proteins, vitamins, fats, carbohydrates, amino acids and minerals (Colak, et al. 2009). The protein content
of mushrooms has been reported to be twice that of vegetables and four times that of oranges and significantly higher than that of wheat (FAO, 2006). The crude fibre content values reported in several studies suggest that mushrooms are potential sources of dietary fibre (Adadayo, 2011). Mushrooms generally contain low fat and oil content (Poppe, 2000). The present proximate analysis of all three mushrooms Lycoperdon pyriforme, Armillaria tabescens and Agaricus bisporus showed 85.4±7.4%, 87.2±6.5% and 90.68±8.3% of moisture, 6.4±0.8 (g/100g), 4.8±1.4 (g/100g) and 5.3±0.53 (g/100g) of ash, 20.3±1.8 (g/100g), 31.46±2.6 (g/100g) and 28.67±2.1 (g/100g) of carbohydrate, 15.28±1.3 (g/100g), 25.32±1.8 (g/100g) and 19.45±1.5 (g/100g) of protein, 2.7±0.21 (g/100g), 3.4±0.21 (g/100g) and 2.8±0.14 (g/100g) of fat and, 14.39±1.1 (g/100g), 18.26±1.2 (g/100g) and 21.37±1.9 (g/100g) of crude fibre content. The proximate concentration of vitamin B1, B2, B3, B6 and B12 content showed some similarities with the total carbohydrate content ranged from 20.54 - 64.78%. A range of carbohydrate values of 53 - 60% of dry weight has been reported for some species of mushrooms (Mendel, 1989) and the carbohydrate content of 20.54 - 64.78% observed in mushroom species C. cibarius, A. caesarea, C. cornucopioides, C. gigantea and B. edulis (Odoh, et al. 2017). The protein content of mushrooms has been reported to be twice that of vegetables and four times that of oranges and significantly higher than that of wheat (FAO, 2006). The fat content of wild mushrooms was within the ranges from 1.1 to 8.1% on dry weight basis (Crisan and Sands, 1978). The lipid content of the present study mushroom also was within the ranges from 2.7±0.21 (g/100g) to 3.4±0.21 (g/100g) showed some similarity with the fat contents of edible mushrooms studied ranged from 1.1 - 8.43%. C. cornucopioides and highest fat contents of 8.43 and 7.32% in T. matsutake while the lowest fat contents of 1.31% in Morchella sp. and C. gigantean (Odoh, et al. 2017). The fat content of the present study mushroom as similar as and slightly higher than the crude fat content of grains such as millet (2.8%) and maize (4.2%) (FAO, 1972).

The present proximate content results observed for all three edible mushroom Lycoperdon pyriforme, Armillaria tabescens and Agaricus bisporus showed ash values ranged from 4.8±1.4 (g/100g) to 6.4±0.8 (g/100g) has some concordance with the total ash content ranged from 6.45 – 38.53% for all edible mushrooms studied and results reported by Kalogeropoulos, et al. (2013) for wild mushrooms from Greece containing 0.46% FW to 0.85% FW ash content and Obodai, et al. (2014) reported level for cultivated mushrooms of Ghana. The high moisture content obtained in the present all three study mushroom Lycoperdon pyriforme (85.4±7.4%), Armillaria tabescens (87.2±6.5%) and Agaricus bisporus (90.68±8.3%) is as similar as when compared with the values (60.70% and 88.40%) reported in mushrooms analyzed by Khurshidul et al., 2010 and Ijoma et al. (2015) and considerably high when compared with ranges of 9.26 – 12.06%, 11.25 – 12.88% and 7.00 – 7.15% reported by Okwelleh and Ogoke (2013), Ezeibeke et al. (2009) and Kayode, et al. (2013) respectively in some mushrooms collected in Nigeria. This high level moisture content in these mushrooms may be due to water soluble enzymes and coenzymes needed for metabolic activities of these mushrooms (Crisan and Sands, 1978, Adejumo and Awesanya, 2005 and Sivrikaya, et al. 2002). The fibres content of the present study ranged from 14.39±1.1(g/100g) to 21.37±1.9 (g/100g) are slightly higher when compared to the crude fibres value ranges (3.32 to 19.76%) for mushroom species C. cibarius, A. caesarea, C. cornucopioides, C. gigantea and B. edulis (Odoh, et al. 2017, Crisan and Sands, 1978 and Mendel, 1989). Due to these significant amounts of fibres content, all present three study mushroom could be regarded as good sources of dietary fiber for supplementation of some foodstuffs with less fiber such as vegetables and helps to prevent constipation, bowel problems and piles.

Vitamins contributes a very small percentage of food in our diet daily, but important in prevention of diseases and longevity (Olaniyi, 2000). The mushrooms contained high folic acid content, an essential vitamin in the maintenance of good health, treatment and prevention of anemic diseases (Refsum, et al. 1998). Nutritionaly, the mushroom has been found to contain vitamins B1 (thiamin), B2 (riboflavin), B5 (niacin), B6 (pyridoxine) and B7 (biotin) (Solomok and Eliseevaa 1988). The vitamin B series such as B1, B2, B3, B6, B7, B9 and B12 concentrations in the fruiting bodies of mushroom were recoded as 0.42±0.071 mg/100g, 0.8±0.093 mg/100g, 3.5±1.6 mg/100g, 0.3±0.014 mg/100g, 0.2±0.006 mg/100g, 5.1±0.53 mg/100g and 0.6±0.042 mg/100g for Lycoperdon pyriforme, 0.51±0.083 mg/100g, 0.6±0.072 mg/100g, 6.1±0.76 mg/100g, 0.1±0.006 mg/100g, 0.027±0.0083 mg/100g, 4.6±0.34 mg/100g and 0.5±0.022 mg/100g for Armillaria tabescens and 0.57±0.092 mg/100g, 0.7±0.08 mg/100g, 5.4±0.51 mg/100g, 0.2±0.085 mg/100g, 0.021±0.0072 mg/100g, 3.9±0.21 mg/100g, 0.8±0.053 mg/100g for Agaricus bisporus. According to the present results, the vitamin B1(thiamine) and B2 (riboflavin) in the present study mushroom were ranged between 0.42±0.071 to 0.57±0.092 and 1.1±0.52 – 0.8±0.093 showed some similarities with mushroom Agaricus bisporus and Lentinula edodes contain B1 and B2 ranges 0.04 to 0.08 mg/100g and 0.04 to 0.3 mg/100g observed respectively by Furlani and Helena, (2008) and 0.05 to 0.19 mg/100 g for Agaricus bisporus (Bautista-Justo, et al. 1998, Esteve, et al. 2001 Llanos, et al. 1993, Mattila, et al. 2001, Olletta, Llanos, Barcos, Ancin and Martin, 2003), 0.05 mg/100 g for L. edodes and 0.07 mg/100 g for Pleurotus (Mattila, et al. 2001) 0.25 mg/100 g of B for the A. bisporus mushroom (Olleta, et al. 1993, Llanos et al. 1993 and Mattila, et al. 2001). The Vitamin B2 observed in the present study mushroom was slightly higher than that of fruits (0.01–0.05 mg/100 g, FAO 1972) but within the range of other mushrooms (Furlani and Godoy 2008), common vegetables (0.1–0.3 mg/100 g), and most common cereals (0.11–0.18 mg/100 g) (FAO, 1972). Vitamin B3 (niacin) of the present study
mushroom were ranged from 3.5±4.6 to 6.1±0.76 considerably lower than that (65 mg/100 g dw) observed in *P. ostreatus* and *L. edodes* 11.9-98.5, A. bisporus 36.19-57.0, and *Pleurotus* mushrooms 33.75-108.7 mg/100 g dw (Crisa and Sands, 1978, Tshinyangu, 1996 and Stoller and Hall, 1988). Vitamin B6 (pyridoxine), is a water-soluble vitamin, necessary for several body functions such as protein, fat and carbohydrate metabolism and red blood cells and neurotransmitters production. It regulate emotions, including serotonin, dopamine and gamma-aminobutyric acid (GABA) and helpful in preventing and treating anemia. Vitamin B6 deficiency causes microcytic anemia, electroencephalographic abnormalities, dermatitis with cheilitis (scarring of the lips and cracks at the corners of the mouth), depression and confusion, and weakened immune functioning (Institute of Medicine Food and Nutrition Board, 1998 and McCormick, 2006). Deficiency in vitamin B9 (Haslam and Probert, 1998) causes megaloblastic anemia, a condition in which the bone marrow produces oversized immature red blood cells. In pregnant women, lack of vitamin B9 can cause severe or even fatal birth defects. The present study mushroom has a considerable amount of vitamin B6 and B9 which is enough to maintain human body healthily. The mushrooms contained high folic acid content, an essential vitamin in the maintenance of good health and prevention of anemic diseases (Rufsum, et al. 1998). Further, folic acid bioavailability in mushrooms is good compared to some vegetables, such as peas and spinach (Clifford, et al. 1991).

The B12 of the present study were ranged between 0.5±0.022-0.8±0.053 which were exactly similar with the ranges 0.6-0.8 µ/100 g dw in cultivated edible mushroom *Agaricus bisporus/white, Agaricus bisporus/brown, Lentinus edodes,* and *Pleurotus ostreatus* observed by Pirjo Mattila, et al. (2001). Vitamin C is a valuable food component because of their antioxidant and therapeutics properties (Bernas, et al. 2006). The vitamin C (Ascorbic acid) content in the present study mushroom was ranged from 13±1.1 to 16±1.3 which was slightly higher when compared to vitamin-c ranged from 70 to 380µg/100g observed in mushroom *Armillaria mellea, Lentinus prolifer, Termitomyces aurantiacus, Termitomyces eurrhizus* and *Termitomyces microcarpus* (Nakambe, et al. 2015). Mushroom is a good dietary source of vitamin D (Glenn Cardwell, et al. 2018). Wild mushrooms have been recognised as the only non-animal food source of vitamin D with reports of high vitamin D2 contents of 3-59 mg 100 g dw.

The present study mushroom *Lycoperdon pyriforme, Armillaria tabescens* and *Agaricus bisporus* contain Vitamin D2 0.150±0.075 mg/100g, 0.172±0.084 mg/100g and 0.168±0.067 mg/100g respectively has a slightly lower when compared with D2 observed in the same *Agaricus bisporus* (0.216 mg/100 g/l) observed by Hanne, et al. (2020) and a smaller amount of vitamin D2 (1.5 µg/100 g FW) was reported in wild *Agaricus* species in Denmark (Kristensen, et al. 2012) and much lower than large amounts of vitamin D2 (21.1 µg D2/100 g FW) observed in wild funnel *chanterelles Cantharellus cibarius* (Fries) (10.7 µg D2/100 g FW), and *Boletus edulis* (58.7 µg D2/100 g FW) (Teichmann, et al. 2007).

Mushroom protein contains amounts of endogenous amino acids, mostly alanine, arginine, glycine, histidine, glutamic acid, aspartic acid, proline and serine (Guo, et al. 2007, Manzi, et al. 1999, Mdachi, et al. 2004, Shah, et al. 1997), as well as all exogenous amino acids. In the present study, the essential amino acids such as arginine, histidine, lysine, tryptophan, phenylalanine, methionine, threonine, leucine, isoleucine and valine were detected in the fruiting bodies of mushroom, *Lycoperdon pyriforme, Armillaria tabescens* and *Agaricus bisporus*. The results of these study showed the arginine levels were in first place which noted as 45.9 mg/g, 67.1 mg/g and 67.1 mg/g. Isoleucine was in second place which was recorded as 45.9 mg/g, 56.3 g/mg and 54.0 mg/g. In terms of individual amino acids, the three most abundant amino acids found in both mushroom species were glutamic acid, aspartic acid, and arginine. In terms of individual amino acids, the three most abundant amino acids found in both mushroom species *Pleurotus ostreatus* and *Pleurotus sajor-caju* were glutamic acid, aspartic acid, and arginine (Pornariya Chirinang and Kanok-Orr Intarapichet, 2009). The concentrations of other amino acids were below to these three amino acids which were sequenced as The other amino acids such as histidine, lysine, tryptophan, phenylalanine, methionine, threonine, leucine, valine and line were sequenced as Leu]>Val>Thr>Ly>His>Phe>Met>Try for *Lycoperdon pyriforme, Val>Leu>Ly>Thr>Phe>His>Met>Try for Armillaria tabescens and Leu>Val>Ly>Thr>His>Met>Phe>Try for Agaricus bisporus* based on their concentration. The amino acids dominancy in their amount is not only dependant on single factor they depend on multifactor such as temperature, humidity, soil condition, rainfall, sunlight and season etc. According to Guo, et al. (2007), the sum of endogenous amino acids in *Pleurotus djamor* was 4481 mg/100 g dry matter and 10291 mg in *Pleurotus ferulae*, making up 53% and 54% respectively of total amino acids. Shah, et al. (1997) found that leucine (18% of total exogenous amino acids) and lysine (15%) were the most abundant exogenous amino acids in dried *P. ostreatus*; however, histidine (4%), methionine (4%) and threonin (3%) were found in the lowest amounts. According to the above authors, the dominant exogenous amino acids in dried *A. bisporus* were leucine (15%) and lysine (17%), with methionine (2%) being found in the lowest amount. According to Guo, et al. (2007) cysteine and valine were most abundant in dried *Pleurotus djamor* mushrooms (15% and 14% respectively of total exogenous amino acids), while leucine (25%) dominated in *Pleurotus ferulae*. However, these authors found that histidine (5%) and methionine (3%) were found in the lowest amounts in *Pleurotus djamor*, and cysteine (3%) in *Pleurotus ferula*. The amino acid arginine in all study mushroom *Lycoperdon pyriforme, Armillaria tabescens* and *Agaricus bisporus* showed phosphorous were in the maximum level which were recorded as 815 mg/100 g, 690 mg/100 g and 734 mg/100 g respectively. The second highest ranges were observed in the sodium which was noted as 75 mg/100 g,52 mg/100 g and 32 mg/100 g and the magnesium comes under in third place in their amount which were recorded as 51 mg/100 g, 47 mg/100 g and 60 mg/100 g in all three study mushrooms. The other minerals such as Calcium (Ca), Copper (Cu), Iron (Fe), Manganese (Mn), Selenium (Se), Potassium(K) and Zinc (Zn) were present in the following sequences based on their amount in all three mushrooms. They are as follows K > Mn > Se > Cu > Zn > Ca > Fe for *Lycoperdon pyriforme, K > Mn > Se > Zn > Cu > Fe for*
for *Arimillaria tabescens* and K > Mn > Sel > Ca > Cu > Zn > Fe *Agaricus bisporus*. Phosphorus is the second most plentiful mineral in your body. It is essential to do certain functions, such as filtering waste and repairing tissue and cells. The calcium present in the human body is around 99% and mostly in its bones and teeth which is essential for the development, growth, and maintenance of bone, blood clotting, maintaining the action of the heart muscle. Third richest level of magnesium in this present study helps to keep blood pressure normal, bones strong, and the heart rhythm steady. Several workers find out the various minerals level in lot of edible and non-edible mushrooms. The phosphorus and magnesium level of the present study is merely similar to the minerals potassium (18.12 mg/100g), sodium (1.21 mg/100g), phosphorus (3.84 mg/100g), calcium (38.12 mg/100g), magnesium (90.82 mg/100g), zinc (1.68 mg/100g), copper (0.54 mg/100g), iron (14.28 mg/100g), and manganese (0.15 mg/100g) observed in mushroom *Pleurotus ostreatus* by Majesty, *et al.* (2018), and the high calcium (38.12 mg/100g) noted in Adejumo, *et al.* (2015). Calcium was one of the predominant elements among the macro minerals measured in the present study which is similar to the mineral content profiles reported for edible mushrooms of *Agaricus*, *Pleurotus*, and *Lentinula* species (Chang and Buswell, 1996. Shah, *et al.*. 1997). Hence, from the present study results it is documented that all three mushroom *Lycoperdon pyriforme*, *Arimillaria tabescens* and *Agaricus bisporus* have become attractive as a functional food and as a source for the development of drugs and nutraceuticals (Lakhanpal and Rana, 2005).

Table 3.1. Proximate contents in the fruting body of mushrooms available in the foothills of Eastern Ghats near Ponnai Village in Vellore District

<table>
<thead>
<tr>
<th>Mushroom species</th>
<th>Lycoperdon pyriforme</th>
<th>Arimillaria tabescens</th>
<th>Agaricus bisporus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrients</td>
<td>Carbohydrate (g/100g)</td>
<td>Protein (g/100g)</td>
<td>Lipid (g/100g)</td>
</tr>
<tr>
<td></td>
<td>20.34±1.8</td>
<td>15.28±1.3</td>
<td>2.7±0.21</td>
</tr>
<tr>
<td></td>
<td>31.46±2.6</td>
<td>25.32±1.8</td>
<td>3.4±0.2</td>
</tr>
<tr>
<td></td>
<td>28.67±2.1</td>
<td>19.45±1.5</td>
<td>2.8±0.14</td>
</tr>
<tr>
<td></td>
<td>14.39±1.1</td>
<td>18.26±1.2</td>
<td>21.37±1.9</td>
</tr>
<tr>
<td></td>
<td>6.4±0.8</td>
<td>4.8±1.4</td>
<td>5.3±0.53</td>
</tr>
<tr>
<td></td>
<td>85.4±7.4</td>
<td>87.2±6.5</td>
<td>90.68±8.3</td>
</tr>
</tbody>
</table>

Table 2. Vitamin concentrations in the fruting body of mushrooms available in the foothills of Eastern Ghats near Ponnai Village in Vellore District

<table>
<thead>
<tr>
<th>Vitamin mg/g</th>
<th>Lycoperdon pyriforme</th>
<th>Arimillaria tabescens</th>
<th>Agaricus bisporus</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>0.42±0.071</td>
<td>0.51±0.083</td>
<td>0.57±0.092</td>
</tr>
<tr>
<td>B2</td>
<td>0.8±0.093</td>
<td>1.1±0.52</td>
<td>0.7±0.08</td>
</tr>
<tr>
<td>B3</td>
<td>3.5±1.6</td>
<td>6.1±0.76</td>
<td>5.4±0.51</td>
</tr>
<tr>
<td>B6</td>
<td>0.3±0.014</td>
<td>0.1±0.006</td>
<td>0.2±0.085</td>
</tr>
<tr>
<td>B7</td>
<td>0.02±0.0065</td>
<td>0.027±0.0083</td>
<td>0.021±0.0072</td>
</tr>
<tr>
<td>B9</td>
<td>5.1±0.53</td>
<td>4.6±0.34</td>
<td>3.9±0.21</td>
</tr>
<tr>
<td>B12</td>
<td>0.6±0.042</td>
<td>0.5±0.022</td>
<td>0.8±0.053</td>
</tr>
<tr>
<td>C</td>
<td>13±1.1</td>
<td>16±1.3</td>
<td>15±1.2</td>
</tr>
<tr>
<td>D2</td>
<td>0.15±0.075</td>
<td>0.172±0.084</td>
<td>0.168±0.067</td>
</tr>
<tr>
<td>D4</td>
<td>0.0064±0.0005</td>
<td>0.0072±0.0004</td>
<td>0.0051±0.002</td>
</tr>
</tbody>
</table>
Table 3. Essential amino acid compositions in the fruiting bodies of three edible mushrooms available in the foothills of Eastern Ghats near Ponnai region, Vellore District

<table>
<thead>
<tr>
<th>Mushroom species</th>
<th>Lycoperdon pyriforme</th>
<th>Armillaria tabescens</th>
<th>Agaricus bisporus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essential amino acids mg/g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arginine</td>
<td>50.8</td>
<td>60.4</td>
<td>67.1</td>
</tr>
<tr>
<td>Histidine</td>
<td>20.3</td>
<td>17.9</td>
<td>22.0</td>
</tr>
<tr>
<td>Lysine</td>
<td>30.2</td>
<td>43.5</td>
<td>41.9</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>05.5</td>
<td>06.7</td>
<td>03.6</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>19.7</td>
<td>23.2</td>
<td>16.9</td>
</tr>
<tr>
<td>Methionine</td>
<td>12.4</td>
<td>15.3</td>
<td>18.1</td>
</tr>
<tr>
<td>Threonine</td>
<td>32.1</td>
<td>41.0</td>
<td>36.8</td>
</tr>
<tr>
<td>Leucine</td>
<td>38.7</td>
<td>43.2</td>
<td>47.3</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>45.9</td>
<td>56.3</td>
<td>54.0</td>
</tr>
<tr>
<td>Valine</td>
<td>36.8</td>
<td>47.1</td>
<td>44.5</td>
</tr>
</tbody>
</table>

Table 4. Minerals concentration in all three edible mushrooms available in the foothills of Eastern Ghats near Ponnai region in Vellore District

<table>
<thead>
<tr>
<th>Mushroom species</th>
<th>Lycoperdon pyriforme</th>
<th>Armillaria tabescens</th>
<th>Agaricus bisporus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals mg/100g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>1.2</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>1.7</td>
<td>1.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.3</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>51</td>
<td>47</td>
<td>60</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>14</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>4.1</td>
<td>3.8</td>
<td>3.2</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>75</td>
<td>52</td>
<td>32</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>815</td>
<td>690</td>
<td>734</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>23</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>Zink (Zn)</td>
<td>1.53</td>
<td>1.96</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Fig 1. Mushroom species collected from foothills of Western Ghats near Ponnai village, Vellore District

**Armillaria tabescens**

**Lycoperdon pyriforme**
References


